Final Report

Financial Analysis of Shrimp Seal of Quality

Submitted to

United States Agency for International Development
Dhaka, Bangladesh

Submitted by
Rezaul Karim Talukder
Md. Saifuddin Shah

August 2005

Table of Contents

ACRONYMS

ATDP	:	Agro-based Industries and Technology Development Project
BCR	:	Benefit Cost Ratio
BFFEA	:	Bangladesh Frozen Food Exporters' Association
BFRI	:	Bangladesh Fisheries Research Institute
BSF	:	Bangladesh Shrimp Foundation
CP	:	Chareon Pokhand (Name of the feed Company)
CST	:	Closed System Technology
DOF	:	Department of Fisheries
DNA	:	De-Oxyribo Nucleic Acid
EPB	:	Export Promotion Bureau
EU	:	European Union
FDA	:	Food and Drug Administration of the United States
FGD	:	Focus Group Discussion
HACCP	:	Hazard Analysis at Critical Control Points
Ha	:	Hectare
MTT	:	Modified Traditional Technology
NGO	:	Non Government Organization
PCR	:	Polymerase Chain Reaction
PL	:	Post Larvae
QUAP	:	Quality Assurance Program
SOQ	:	Seal of Quality
SSOQ	:	Shrimp Seal of Quality
Tk.	:	Taka (Bangladeshi currency)
TOR	:	Terms of Reference
TSP	:	Triple Super Phosphate
USAID	:	United States Agency for International Development
WSSV	:	White Spot Syndrome Virus

Executive Summary

Introduction

The shrimp sector of Bangladesh exhibited a phenomenal growth over the past three decades. With the influx of viral disease from mid nineties, the production started to have setback. Because of the two prong effects of disease and bacterial contamination/adulterations, Bangladeshi shrimp started to lose ground in the international market. Efforts were under way to resolve the crisis by adopting different measures such as the Quality Assurance Program of the BFFEA. Another initiative was conceptualization of the Seal of Quality (SOQ) program through the Agro-based Industries and Technology Development Project (ATDP). This initiative was subsequently renamed as the Shrimp Seal of Quality (SSOQ). Although initially it was perceived as exclusively a certification program, production improvement through use of disease free larvae and improved pond management was also included as an agenda of the SSOQ program.

The pond demonstration program was introduced from 2003 and by early 2005, some impacts of the program started to be visible. The project people also started claiming some success in terms of improvement in pond productivity and export earning due to implementation of the project in the coastal region of Bangladesh. The USAID wanted to have an evaluation of the project with particular reference to its claim of productivity and export gains. The purpose of this exercise is to perform this evaluation and verify the financial contributions the SSOQ has made to the participant farmers, processors and exporters of shrimp.

Methodology

Rapid assessment technique was used in the evaluation exercise. To assess the impact of SSOQ technology, both 'with and without' and 'before and after' approaches were adopted. Production performance indicators of the adopter farmers were compared with those of the non-adopter farmers. Also, performance indicators of the adopter farmers after adoption were compared with their performance before adoption of the technology.

For comparing productivity and profitability of the adopter and non-adopter farmers a small sample survey was conducted in 4 thana locations of 3 districts namely Khulna, Satkhira and Bagerhat. Data were collected from a total of 65 farmers, selected through purposive and random sampling techniques. Structured interview schedules were developed and used to collect data from the selected categories of farmers. Semi-structured interviews were also conducted with the SSOQ personnel, DoF Extension Officers and other knowledgeable persons including the BFRI scientists. Also, 'focus group discussion' was organized to identify the management practices followed and the constraints associated with production and marketing of shrimp. Apart from the field level investigation, semi-structured interviews were also conducted with relevant stakeholders such as the representatives of the Bangladesh Frozen Food Exporters' Association (BFFEA), Bangladesh Shrimp Foundation (BSF), Department of Fisheries (DoF) and Export Promotion Bureau (EPB).

The collected data were processed using the Microsoft Excel package. Statistical measures such as mean, percentage, range and ratios were derived and interpreted to accomplish the objectives of the evaluation.

Shrimp Culture Technology and SSOQ Interventions

The technology package devised and popularized by the SSOQ in the field were supply of virus free post larvae (PL) and a set of pond management practices under two broad categories of technology namely Closed System Technology (CST) and Modified Traditional Technology (MTT).

Testing for Disease Free PL

The SSOQ program established a viral DNA identifying protocol laboratory through Polymerase Chain Reaction (PCR) technology at Cox's Bazar. The protocols used in the viral DNA testing are in the form of testing kits and offer a ready hand stock of chemicals and speedy preparation of samples and detection procedures. The physical facilities available in the laboratory are enough to carry out the expected number of tests for certification of virus free supply of seeds in line with the demand.

Closed System Technology (CST)

In this technology, the pond is thoroughly cleaned and disinfected by bleaching powder, at the dose of 600kg/ha. A reservoir tank of upto a maximum of 30% of the total grow-out pond area is maintained near the grow-out pond(s). The water of the reservoir pond is also bleached with the same dose of bleaching powder, and stand-by water is maintained for making good of the water losses from the culture pond due to seepage and evaporation. The pond is also applied with organic materials like mustard oil cake, molasses and rice bran during early stages of growth and development of the shrimp. The technology necessitates high level of supervision and monitoring on the part of the SSOQ's field level extension agents.

Modified Traditional Technology (MTT)

This technology is a modification of the Closed System culture technology. In this system, virus free PLs are nursery-reared at relatively high density for up to one month. The nursery is cleaned and disinfected with bleaching powder at the dose of 600 kg/ha and fertilized with urea and TSP. The PLs are fed with CP starter feed for one month in the nursery and then released in the untreated pond. The principal technical interpretation that goes in favour of the technology is that because the virus free PLs are nursery-reared in the well prepared disinfected nursery for a month, and since the virus attack generally starts at the age of 80 to 90 days, the shrimp by that time become sizeable for harvest and farmers can be saved from the loss in the event of virus attack in the grow-out pond.

Financial Analysis of Shrimp Seal of Quality

Stocking Density and Survival Rate of Fry and Shrimp

Stocking density was the highest (62,700/ha) for CST and lowest (22,969/ha) for MTT farms. Non-SSOQ farms had the second highest stocking density (31,462/ha). Fry survival rate was the highest for MTT (84%) and lowest for non-SSOQ farms (44%). Fry survival rate for CST farms (79%) was closer to that of the MTT farms. Shrimp survival rates of the CST and MTT farms were much higher (65% and 59% respectively) than those of the non-SSOQ farms (25% only). Thus overall survival rates were overwhelmingly higher for the SSOQ than for the non-SSOQ farms.

Pond Productivity of the Farmer Groups

Average per hectare yields of farmers practicing Closed System Technology, Modified Traditional Technology and non-SSOQ technology were 1140 kg, 338 kg and 209 kg respectively in 2004. The average yields of the CST farms were 293 kg in 2003, 1140 kg in 2004 and 1243 kg (expected) in 2005. For the MTT farms, the average yields were 155 kg in 2003, 338 kg in 2004 and 435 kg (expected) in 2005. The yield increases of the CST farmers were 288% from 2003 to 2004, 9% from 2004 to 2005 and 323% from 2003 to 2005. For the MTT farms, yield increases were 118% from 2003 to 2004, 28% from 2004 to 2005 and 181% from 2003 to 2005. Thus the adopter farmers in general obtained substantially higher yield after adoption of the SSOQ technology.

Costs and Returns of Shrimp Culture under Alternative Technologies

Per hectare gross returns of the CST, MTT and non-SSOQ farms were Tk. 405,725, Tk. 117,447 and Tk. 75,618 respectively. Net returns per hectare of the corresponding groups were Tk. 97,089, Tk. 42,788 and Tk. 1,434 respectively. Although net returns of the CST farms were more than twice the net returns of the MTT farms, return per Taka invested for the former group was lower than that of the latter group of farms. Six out of 21 CST farms, 6 out of 16 MTT farms and 14 out of 28 non-SSOQ farms earned negative net returns in the 2004 production cycle. Break-even yields were 867 kg, 215 kg and 205 kg per hectare for the CST, MTT and non-SSOQ farms respectively. From investment point of view, MTT farms were more profitable than the CST farms.

Adoption of Technology

Records obtained from the District Fisheries Offices of Khulna, Satkhira and Bagerhat showed that there were 44,141 brackish water shrimp farms in these areas. Data obtained from the SSOQ office showed that there were only 274 farmers who adopted SSOQ technologies over a three years period of demonstration in the areas. Thus in percentage term this was quite a negligible (<1.0 percent) figure and could not be termed as any substantial magnitude of adoption. However, the team observed through field visits that farmers adopting the technologies, particularly the CST adopters were quite seriously practicing the technologies in terms of adherence to the recommended practices pertaining to the component elements of the technologies.

One unique feature observed was maintenance of written records of all the management practices and financial transactions by the farmers. The farmers were able to provide all required information in absolute or parameterized forms from the written records. They reported that they were taught these record keeping practices by the project personnel. This could be regarded as a remarkable contribution of the project initiative.

All the SSOQ adopter farmers expressed their willingness to continue with the SSOQ technology because they got stimulated by the increased survival rates of the fries/shrimps, high yield and hence good financial returns. There were, however, a few instances of crop failures and farmers, with assistance from the technical experts of the project, identified that in most cases the failures were due to some lapses in pond management practices.

Spillover Effect of Technology Adoption

Attempt was made to assess the spillover effect from the responses of the adopter farmers on the question of number or proportion of neighboring farmers adopting the reference technologies. Responses obtained from 21 CST farmers revealed that 75 neighboring

farmers adopted the technology and another 810 showed interest in the adoption. As for the MTT, responses obtained from 16 adopter farmers revealed that 24 neighboring farmers adopted the technology and another 259 showed interest in the adoption. MTT was introduced only from early 2005 and just one crop was harvested by mid July 2005. Thus the impact of the technology was yet to be amply manifested in the areas.

Responses obtained from the non-adopter farmers showed that of the 28 non-adopters, all reported to have heard about the SSOQ technology and 22 of them (78%) were willing to adopt the technology. Thus there was a reasonably high spillover effect of the SSOQ technology in the shrimp belt areas of Bangladesh.

Impact of SSOQ Technology on Export Earning

There has been an attempt through the SSOQ initiative to estimate the project's impact on shrimp export on the basis of virus free larvae released through the PCR laboratory of Cox's Bazar station. The estimate is based on a number of assumptions, some of which might appear to be quite fragile. In the first place, certain specified quantity of PL would have to be tested through the PCR lab owned by the project. Second, the survival rate has been assumed to be 33 percent. Results obtained from the survey revealed that survival rate of commonly available fry in the ordinary pond was only about 12 percent. A particular survival rate of the disease free PL (question remaining as to how long the PL would remain disease free under ordinary management) in the ordinary pond has not yet been established. Also, it has been assumed that all the shrimp produced would find their way in the export market. The plausibility of all these assumptions may be questionable. Thus, derivation of the export earning figure does not appear to stand on a solid ground. However, since the project is significantly contributing to productivity of shrimp, its potential impact on export need not be undermined and potentially, the project can make even bigger contribution to export in the near future.

Financial Sustainability Plan of SSOQ

The SSOQ initiative has recently done an exercise on "hypothetical revenue generation", based on the assumption of testing a specified number of larvae. There is nothing wrong in doing such an exercise, based on a set of assumptions. The critical issue will be execution of the plan in terms of number of PLs being tested per time period and collection of charge at a market determined rate. It should be mentioned that the PCR lab owned by the SSOQ is not likely to be the only lab in the area. One hatchery (Niribili) has already a PCR testing lab and other labs may be established in the area. Thus SSOQ would be expected to run the PCR lab on a commercial basis in a future market scenario. The plan will therefore need to stand the test of time and circumstances obtaining round the shrimp industry in Bangladesh.

Conclusions and Recommendations

Conclusions

The Shrimp Seal of Quality Initiative seems to have been making substantial positive impact on pond based shrimp culture in the south western coastal region of Bangladesh. Provision of disease free post larvae and innovative pond management practices have contributed to substantial yield increase. Results from farm survey have shown that farms adopting SSOQ technology obtained much higher yield than those not adopting the technology. For the adopter farms, yield after adoption was much higher than that before adoption.

Financial benefits were also much higher for the adopter farms compared to the non-adopter farms. For the adopter farms, while gross return for the CST farms was several times higher than that for the MTT farms, net return for the former was about twice the net return of the latter category of farms. However, the benefit-cost ratio, which represents return per Taka of investment, was substantially higher (1.57) for the MTT than for the CST farms (1.31). Thus from investment point of view, MTT farms were earning more return from their investment than the CST farms.

The SSOQ technology seems to be rapidly expanding in the shrimp belt areas of Bangladesh. Field visits revealed that quite a good number of neighboring farms already adopted the technologies by following the management practices being pursued by the SSOQ adopter farms.

The proposition of the project's making any significant contribution to export earning seems to be premature; the prospect of making such contribution in the near future seems to be quite high though. The proposition of financial sustainability of SSOQ as a Private Limited Company has to stand the test of time and circumstances obtaining round the shrimp industry in Bangladesh.

The most weak dimension of SSOQ operation is its lack of understanding and cooperation/collaboration with some vital public and private sector bodies such as DoF, BFRI and BFFEA. Effective collaboration with the related institutions and organizations are not only important during project implementation, but also for sustainable utilization of the technologies and other positive impacts that the project leaves behind.

Recommendations

It has been evident through the Evaluation that a lot of positive impacts have been generated in the shrimp production sector through the SSOQ efforts. Since the project has performed only for less than three years, it is suggested that the efforts be continued for a few more years (3-5 years) so that the positive impacts can be further propagated and the results can be consolidated. However, a number of issues need to be addressed for obtaining sustainable outcomes from the project initiatives. These are outlined below:

- There should be separate technology for catching brood shrimp from the sea for ensuring sustainable harvest of brood shrimp. Program for domestication of broods can also be taken up as a long term gesture,

especially in view of seasonality and uncertainty of brood availability in the off seasons.

- Synchronization of requirement of virus free seed in the field and production or supply of seed the through PCR testing is a critical determinant of efficient utilization of the PCR tested seed. Measures should be taken to match the demand with supply through careful planning and prior scheduling of breeding/spawning and stocking.
- Mortality rate of the PL should be further minimized. Nursery management system should be improved at different stages such as at the hatchery, at the sales centre and also at farm level.
- Inter agency collaboration should be improved for deriving better outcomes from the technology generation and dissemination efforts. The SSOQ authority should take fresh initiative to secure collaboration with DOF, BFRI and BFFEA for obtaining sustainable improvement in production, processing and export of good quality shrimp from Bangladesh.
- The project should leave behind a set of well trained farmers and extension agents for widespread dissemination of the technologies in the self propelling manner. The critical issue would be to organize the trained farmers into viable groups, so that they would be interacting among themselves in matters of trouble shooting and sustainable management of the technologies. The research and extension support from public, private and NGO sectors would be highly desirable and effective in accomplishing the desired outcomes.

Financial Analysis of Shrimp Seal of Quality

1.0 Introduction

1.1 Background of the Shrimp Seal of Quality Initiative

Shrimp farming and related activities contribute significantly to the national economy of Bangladesh. The main areas of contribution are export earning, and employment and income generation through on- and off-farm activities. It is estimated that about 600,000 people are employed in the shrimp sector and over 10 million people are directly or indirectly benefited from the sector. Total shrimp catch in 2003-04 from coastal shrimp farms was estimated at 75,166 metric tons from about 203,000 hectare area (DOF 2005). Bangladesh exports about 30 thousand metric tons of frozen shrimp annually, valued at approximately US $ 300 million. This figure represents about 6 per cent of total annual exports from Bangladesh.

Shrimp culture in Bangladesh has been characterized lagely by extensive traditional methods, with low yield and low capital inputs. Upto the mid nineteen eighty period, most of the shrimp fries used to come from wild catch. From late eighties there were massive efforts to establish shrimp hatcheries in the country. Available reports suggest that about 55 *bagda* shrimp hatcheries have been established in the country by the year 2004. All the hatcheries are located in the Cox's Bazar area. However, not all the hatcheries are in operating condition, and about 80% are reportedly in operation in the current year. Seventy percent of the seed requirement is being met by the hatchery-produced PLs and the rest 30% is still being supplied from the wild catch. Information gathered from the DOF Officials and other sources suggest that there is no current evidence on import of shrimp seed from foreign countries. However, some unconfirmed reports suggest that some nursery owners of Satkhira area bring nauplii (shrimp seed between spawn and post larvae stage) from India, rear them upto PL size and then sell to the farmers.

Although productivity of Bangladeshi shrimp was low by international standard, the quality and size of the shrimp had rather appreciation in the international market and thus the farmers and exporter used to earn good profits. The initial success stimulated rapid expansion of shrimp farms, often with inappropriate farming practices. From early 1990s semi-intensive farming was introduced. However, with the introduction of this system, many farms became infected with white spot viral disease. As a result, the farms started incurring loss.

The sector received another setback in 1997 when the European Union (EU) imposed a ban on entry of Bangladesh's frozen food for the failure to comply with EU regulations on quality control. This led to the realization of the need for better quality control practices using the Hazard Analysis at Critical Control Point (HACCP) program. However, problems with quality still remained and in December 2004, the United States Food and Drug Administration (FDA) rejected some shipment of shrimp from Bangladesh.

Because of the two prong effects of disease and adulteration/contamination, the shrimp industry of Bangladesh fell on the verge of serious crisis. In an effort to solve these problems, the Bangladesh Frozen Food Exporters Association (BFFEA) took a decision to launch its Quality Assurance Program (QUAP) to ensure that products are processed and packed in accordance with international guidelines. However, the program did not work well and the problem of quality continued to exist.

In 2002, the concept of Seal of Quality (SOQ) was introduced through the Agro-based Industries and Technology Development Project (ATDP II). The BFFEA initially welcomed the initiative. But at some stage the BFFEA people felt that the program might not serve their interest better and therefore they started to be alienated from it. The Department of Fisheries (DOF) also did not lend support to the program. Eventually, ATDP unilaterally continued to pursue the initiative. After a lot of brainstorming, it was decided to rename the program as Shrimp Seal of Quality (SSOQ) as the main focus was on shrimp. It was initially conceived as a certification program. In order to address the issue in a more comprehensive way,

involving production and processing, a production demonstration program was undertaken in selected field locations of Khulna, Satkhira and Bagerhat districts.

1.2 Background of the Evaluation

The pond demonstration program of the SSOQ was put in the field with a set of technologies. The prime element of the package of technology was the use of Polymerase Chain Reaction (PCR) tested White Spot Syndrome Virus (WSSV) free post larvae (PL). The project established a PCR laboratory in Cox's Bazar through which disease free PL is released to the field. Two major technologies are being tried in the field: Closed System Technology (CST) and Modified Traditional Technology (MTT). The project has meanwhile claimed some remarkable success in terms of gain in productivity, dissemination of the technologies and prospective gain in export earning.

The ATDP is scheduled to end in December 2005. In March 2005, an evaluation of the whole ATDP including the SSOQ activities was done by an American consulting firm named Development Associates, Inc. The USAID wanted to have a separate in-depth analysis of performance of the SSOQ in terms of pond productivity, adoption rates and export sales. The present assignment is based on a decision of the USAID to carry out a financial analysis of the SSOQ covering the above aspects. The assignment had the following terms of reference (TOR):

- To verify the degree of increase in pond productivity attributed to the introduction of SSOQ technology;
- To conduct a cost-benefit analysis between farmers who have not adopted the SSOQ technology and those who have;
- To comment on the rate of adoption of SSOQ technology;
- To comment on 'spillover' effect of technology adoption;
- To verify the SSOQ's reports that a multi-million dollar increase in export sales can be attributed to the project's intervention, specifically with the screening and release of disease-free PL;
- To comment on the financial sustainability plan proposed for SSOQ.

2.0 Methodology

Rapid assessment technique was used in the evaluation exercise. To assess the impact of the SSOQ technology, both "with and without" and "before and after" approaches were adopted. In the "with and without" approach, performance indicators of the adopter farmers were compared with those of the non-adopter farmers. In the "before and after" approach, performance indicators of the adopter farmers after adoption were compared with their performance before adoption of the technology.

2.1 Data Collection and Related Instruments

In order to compare productivity and profitability, a small sample survey was conducted in 4 Thana locations of 3 districts, namely Khulna, Satkhira and Bagerhat. Data were collected from a total of 65 sample farmers, selected through purposive and random sampling techniques. There were 274 SSOQ technology adopter farmers from which 37 were selected for interview. The purpose was to put more weight to the old adopters and hence include higher proportion of farmers from those groups in the sample. To compare the performance, data were also collected from 28 non-adopter farmers from the same 4 locations. Technology wise, samples were selected from 3 categories of farmers namely the adopters of Closed System Technology, those of Modified Traditional Technology and non-adopters of SSOQ technology. Distribution of the sample respondents by location and technology is presented in Table 2.1.

Table 2.1: Distribution of sample respondents by location and farmer category

District	Thana	SSOQ		Non-SSOQ	Total
		Closed System Technology (CST)	Modified Traditional Technology (MTT)		
Bagerhat	Sadar	9	2	6	17
	Rampal	5	7	6	18
Khulna	Paikgacha	2	3	10	15
Satkhira	Debhata	5	4	6	15
Total		21	16	28	65

Data were collected from the sample respondents by administering structured interview schedules. The sample copies of the interview schedules are provided in the Appendix. Four Field Enumerators were appointed, each for one weak, to collect data from the 4 locations. Semi-structured interviews were conducted with the SSOQ project personnel, local DOF Extension Officers, and other knowledgeable persons including the BFRI scientists. Semi-structured interviews were also conducted with personnel of other stakeholder organizations such as Bangladesh Frozen Food Exporters' Association (BFFEA), Bangladesh Shrimp Foundation (BSF), and Export Promotion Bureau (EPB). In addition, Focus Group Discussion (FGD) was conducted for both adopters and non-adopters of SSOQ technology. The purpose of the FGD was to identify the management practices followed and the constraints associated with adoption and management of the technologies.

2.2 Data Management

The quantitative data were entered into the computer using the Microsoft Excel package. The qualitative data were also entered into the computer and the relevant information were obtained using the coding and decoding procedures. Statistical measures such as mean, percentage, range and ratio were derived and interpreted to depict the pictures obtained from the data.

3.0 Shrimp Culture Technology and SSOQ Intervention

Certain technological aspects, including provision of disease free PL critically determine the performance of shrimp production at farm level. If the PLs are obtained in virus free condition, the production and growth can be maintained through a system of farm management that ensures protection against contamination. This section gives a brief description of a number of shrimp culture technologies which have been innovated and are being popularized through the SSOQ initiative.

3.1 The Components of the Technology

3.1.1 Virus Free Post Larvae Supply

The issue of a guaranteed and sustained supply of good quality PL starts right from the hatchery. All the hatcheries are established in the Cox's Bazar area, for the primary reason that the mother shrimps are caught from the deep sea by the marine artisanal fishermen and are sold to the hatcheries. Availability of good quality saline water in the Cox's Bazar area is an important reason for concentration of hatchery establishment in the area. The mother shrimps are caught by the artisanal fishermen mainly as by-catch as there is no separate technology for catching brood shrimp. However, for sustained availability of good quality brood shrimp, separate technology should be used for catching brood shrimp from the sea.

Although a virus positive mother would be expected to produce virus positive spawn, it is gathered that this might not always be the case. Similarly, a virus negative mother can give virus positive PL also. Thus testing of a mother for WSSV virus negative with PCR technology does not give guarantee of getting virus free PL. The maintenance of hatchery health, hygiene and sanitation are the critical determinants of getting healthy and disease free PL. Virus may not be there with the brood mother, but any chance of contamination in the system can seriously deteriorate the quality of the PL produced in a hatchery.

3.1.2 Technical Manpower

Availability of trained hatchery technician is an important determinant in the success and sustainability of the hatchery technology. Many of the bagda shrimp hatcheries are being run by the foreign technicians. The foreign technicians are not generally willing to teach the local technicians the technical details of the management. It is even apprehended by some of the hatchery owners that there may remain the chance of use of food additives, chemicals and antibiotics in the process of PL production by the foreign expert technicians, outside the knowledge of the hatchery owners. It is, therefore, important to ensure transparency in the use of chemicals in the hatcheries and to transfer the technologies to the local trained technicians for sustainable use of the technology.

3.1.3 Seasonality of Culture and Brood Availability

With the advent of hatchery technology during the last one-decade or so, the culture cycle in the farms has been doubled or even tripled. But there has not been any synchronized and coherent system of supply of seed from the hatcheries. In Bangladesh, there are two broad seasons that very much determine the culture regime of shrimp at farm level. The peak culture season is January to March; there being another short season in some areas of Satkhira during winter period of November to December. During the peak season there is high demand for seed and the hatcheries are capable of meeting the demand.

Brood available during January to March are reported to be of good quality and a single brood is capable to produce upto 5,00,000 PL having 80% survivality. During this season, upto 50% of the females can be spawned without eye ablation, a technique by which one of the eye stalks of the female is cut to quicken maturation for artificial breeding. Problems arise in the off season during April to August, when the conditions of the broods deteriorate and only up to 5-6% females caught are found in breeding conditions. Many of the hatcheries do not run their operation in this season because of uncertainty of the brood availability. As a result, there arises a shortfall in the supply in relation to the demand for stocking for second and/or third crop of the annual production cycle.

3.1.4 Nursery Technology Development

For an ideal culture situation, there can be nursery arrangement of the larvae in at least three stages in the process of production, transportation and culture. It was gathered from the visit to the hatcheries in Cox's Bazar that PLs of 12 day old size are sold to the local culture farms and those of 15-17 day old size are sold to the culture farms of Khulna/Satkhira areas. There are nursery arrangements in each hatchery where 11-12 day old PLs are transferred to another tank and reared there for upto 25-26 days before being sold to the culture farms. This is known as green water culture. The demand for PL is higher in Khulna, Bagerhat and Satkhira areas and in these days PLs are air transported by cargo planes. Careful estimates suggest that it takes about 16 hours for the PL to reach the culture site through air transportation from Cox's Bazar to Jessore. The duration is quite long and if the PLs are not packed in proper conditions, mortality increases. For this reason, nursery arrangement is also necessary at the marketing sites.

3.2 SSOQ's PCR Testing Laboratory

The SSOQ program has established a viral DNA identifying protocol laboratory through PCR technology at Cox's Bazar. The laboratory is managed by two technical personnel and is capable of testing the total number of PLs required by the culture farms. The protocols used in the viral DNA testing is in the form of testing kits and offer a ready hand stock of chemicals and speedy preparation of samples and detection procedures. The hatcheries have also been interested in the technology as virus free seed fetch higher price in the market. The number of manpower, their technical capability and physical facilities in the laboratory are just enough to carryout the expected number of tests for certification of virus negative supply of seeds in line with the demand. However, there is a clear concern in the synchronization between the demand in the culture farms and production or supply of the seed through the testing laboratory. During the field visit it was observed in Bagerhat that a consignment of PCR tested seed brought for the SSOQ farmers were to be sold to the non-SSOQ farmers because of untimely arrival of the seed.

3.3 Culture Technology

3.3.1 Culture Sites

The SSOQ's demonstration farms are all located in the southwest coastal districts of Satkhira, Khulna and Bagerhat. These are the principal *bagda* shrimp producing areas of the country. Under the existing traditional system of culture, the selection of site for construction of farms has always been a crucial matter. Selection of site has to be given a very high consideration. During field visit it was observed that site selection for the Closed System Culture was inappropriate, with the consequent mortality and death of the whole crop, even though the seed used was virus free. Availability of water, maintenance of proper depth in the pond, soil types and topography, and good communication system are the prime considerations in site selection.

3.3.2 Closed System Technology (CST)

In this technology, the pond is thoroughly cleaned and disinfected by bleaching powder, at the dose of 600 kg/ha. A reservoir tank of upto a maximum of 30% of the total grow-out pond area is maintained around the grow-out pond. The water of the reservoir pond is also bleached with the same dose of bleaching powder, and stand-by water is maintained for making good of the water losses from the culture pond due to seepage or evaporation. The average area of the pond used under the technology during 2004 was 0.76 ha. Fertilization of the pond is done with Urea and TSP after 3-5 days of bleaching and when the water color starts turning greenish, the PLs are stocked in a fine-meshed net enclosure inside the pond at a density of up to 9-10 PLs/m^2. Nursery in the net enclosure is maintained for up to 3 weeks. During this period the PLs are fed with starter feed of CP Company. After 3 weeks the net enclosure is removed.

The pond is also applied with organic materials like mustard oil cake, molasses and rice bran during early stages of growth and development of the shrimp. These applications are reported for both fertilization and feeding. At the later stages, the shrimps are fed with CP feed of Thailand, fed at satiation level, 4-5 times a day based on checking the feeding trays dipped at different locations of the pond. The

technology necessitates high level of supervision and monitoring on the part of the SSOQ's field level extension agents. Use of bleaching power for pond water treatment has been said, especially by DOF personnel, to have detrimental effect on the organic environment. Such claim has not been substantiated by any published reference. However, the chemical is known as hazardous for human health, especially at the handling stage. Thus, there can be extension efforts for training on safe handling of the chemical by the often-illiterate farmers.

3.3.3 Modified Traditional Technology (MTT)

This technology is a modification of the Closed System culture. Evidently, the Closed System culture is a cost- and management-intensive technology and a large number of farmers can not actually afford it. To devise a technology suitable for relatively resource-poor farmers, modifications have been brought in the type of management. In this system, virus free PLs are nursery-reared in a nursery pond made within or beside the traditional gher/pond for upto one month. The principal technical interpretation that goes in favour of the technology is that because the virus free PLs are nursery-reared in the well prepared disinfected nursery for a month, and since the virus attack starts at the age of say 80 to 90 days, the shrimp by that time become sizable for harvest and the farmers can be saved from the loss in the event of virus attack in the grow-out pond. The nursery used in this system is cleaned and bleached with bleaching powder at the dose of 600 kg/ha and fertilized with Urea and TSP. The PL is fed with CP starter feed. The stocking density is maintained at much lower rate of upto 4 PL/m^2.

4.0 Financial Analysis of Shrimp Seal of Quality

4.1 Socioeconomic Characteristics of the Farmers

Socioeconomic attributes examined were age and education of the farmers, their levels of training on fish culture, land area owned, pond area owned and operated, and annual household income. Table 4.1 shows the socioeconomic attributes of the three categories of farmers. Irrespective of categories, farmers were at their middle age of around 40 years. On an average, CST farmers had 12 years of formal education. The non-SSOQ farmers, on an average, had 8 years of formal schooling. Thus the adopters of SSOQ technology had relatively higher level of education than the non-adopters. Land ownership was highest for CST farmers and lowest for non-SSOQ farmers. Average pond area cultured was the highest for non-SSOQ farmers and lowest for CST farmers. Thus the intensity of culture was inversely related to size of pond cultured. As would be expected, gross annual income was the highest for the CST farmers and lowest for the non-SSOQ farmers. Gross income of the former group was about seven times higher than that of the latter group. However, gross income of the MTT farmers was only about 50% higher than that of the non-SSOQ farmers.

Table 4.1: Socioeconomic characteristics of the sample shrimp farmers

Farm category	No. of farms	Age (years)	Education (years of schooling)	Land area owned (ha)	Pond area owned (ha)	Pond area cultured in 2004 under reference technology (ha)	Days of formal training received in 2004	Gross annual household income (Tk)
SSOQ:CST	21	42	12	9.50	8.97	0.76	2	1484444
SSOQ:MTT	16	38	11	4.06	2.44	1.31	7	344708
Non-SSOQ	28	41	8	2.60	2.26	2.63	4	221171

Note: CST = Closed System Technology, MTT = Modified Traditional Technology
Source: Field Survey 2005

4.2 Stocking Density and Survival Rate of Fry and Shrimp

Adopters of the SSOQ technology generally stocked seeds twice in one year production cycle. Non-SSOQ farmers, however, stocked several times in a year. Table 4.2 shows that stocking densities in the 1st stocking were 62716, 22969 and 31462 for CST, MTT and non-SSOQ farmers. Fry survival rates of the CST, MTT and non-SSOQ farmers were 79%, 84% and 44% respectively. Shrimp survival rates, counted after harvest, were 65%, 59% and 25% for the CST, MTT and non-SSOQ farmers respectively. Thus survival rates of the non-SSOQ farmers were much lower than those of the SSOQ farmers. The non-SSOQ farmers bought shrimp seed from more than one sources. Of the 28 non-SSOQ farmers, only 8 bought seed exclusively from hatchery. While 9 farmers used seeds from wild catch only, 11 farmers used seeds from both hatchery and wild catch.

Table 4.2 shows that there were significant drops in the survival rates from fry stage to shrimp stage. Discussion with extension personnel and farmers during field visits revealed that for non-SSOQ farmers, the major part of the drop was due ton disease. For SSOQ farmers, for whom the drop was relatively lower, poor pond management by some farmers was the main cause.

Table 4.2: Stocking density and fry/shrimp survival rate by farmer category

Farmer category	Stocking density per hectare (2004)		Fry survival rate (%) (2004)	Shrimp survival rate (%) (2004)
	1st stocking	2nd stocking		
SSOQ:CST	62716	54725	78.62	64.89
SSOQ:MTT	22969	17538	84.31	59.10
Non-SSOQ	31462	6659	44.00	24.67

Source: Field Survey 2005

4.3 Pond Productivity of the Farmer Groups

Table 4.3 shows per hectare shrimp yield of the farmer groups. The focus is on the year 2004 which represents yield of all the adopter and non-adopter categories of farmers during the operation of project. The average yield in 2004 for the CST, MTT and non-SSOQ farms were 1140 kg, 338 kg and 209 kg per hectare respectively. The maximum yield for the categories of farms were 2068 kg, 1839 kg and 795 kg, and the minimum yields were 49 kg, 118 kg and 99 kg

respectively. The percentage difference of yield between CST and non-SSOQ farms was 444 per cent and that between MTT and non-SSOQ farms was 61 per cent (Table 4.3). Thus the CST farmers had overwhelmingly (about 5 times) higher yield than the non-SSOQ farmers. However, the MTT farmers had only moderate yield increase over the non-SSOQ farmers. The successive higher yields of the SSOQ farmers would be attributed to increased adherence to the more refined technologies over time. The marginal increase in yield of non-SSOQ farmers over time might be attributed to the spillover effects of the technologies in the respective areas.

Table 4.3: Shrimp yield and related statistics of the adopters and non-adopters of the SSOQ technology

Farmer category	Shrimp yield (kg/ha)								
	2003			2004			2005		
	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
SSOQ:CST	293.61	1808.61	0.00	1140.10	2067.91	49.40	1243.18	2857.85	0.00
SSOQ:MTT	154.73	432.25	0.00	338.12	1839.36	117.50	435.61	869.87	0.00
Non-SSOQ	166.17	714.30	0.00	209.45	795.27	98.80	184.85	934.59	0.00
% difference between CST and non-SSOQ	76	-	-	444	-	-	572	-	-
% difference between MTT and non-SSOQ	7	-	-	61	-	-	135	-	-

Source: Field Survey 2005

Table 4.4 shows a picture of yield difference of the SSOQ technology adopters before and after adoption of the technology. It should be mentioned that most farmers adopted the CST technology in 2004 and no farmer adopted the MTT technology before 2005. Thus for the CST and MTT farmers the bench mark years were respectively 2003 and 2003/2004. Table 4.4 shows that yield increases of the CST farmers were 288% from 2003 to 2004, 9% from 2004 to 2005 and 323% from 2003 to 2005. For the MTT farmers yield increases were 118% from 2003 to 2004, 28% from 2004 to 2005 and 181% from 2003 to 2005. Thus the adopter

farmers in general obtained substantially higher yield after adoption than before adoption of the SSOQ technology.

Table 4.4: Shrimp yield and related statistics of SSOQ adopters before and after adoption of the technology

Farmer category	Average yield (kg/ha)			% increase in 2004 over 2003	% increase in 2005 over 2004	% increase in 2005 over 2003
	2003	2004	2005			
CST	293.61	1140.10	1243.18	288	9	323
MTT	154.73	338.12	435.61	118	28	181

Note: Yield of 2005 represents the actual production of the 1st harvest and expected production of the 2nd /remaining harvest(s).
Source: Field Survey 2005

4.4 Costs and Returns of Shrimp Culture under Alternative Technologies

Costs, returns and profitability of shrimp culture under alternative technologies for the year 2004 are presented in Table 4.5. Costs have been shown in two broad categories: fixed and variable costs. Returns represent value of shrimp produced over one year production cycle for all categories of farms. Gross costs per hectare of shrimp production were Tk. 308,636, Tk. 74,659 and Tk. 74,184 for CST, MTT and non-SSOQ farms respectively. Gross returns per hectare for the above categories of farms were Tk. 405,725, Tk. 117,447 and Tk. 75,618 respectively. Gross margin, which represents return over variable cost, were Tk. 134,836, Tk. 64,852 and Tk. 23,403 for CST, MTT and non-SSOQ farms respectively.

As can be seen from Table 4.5, shrimp prices received were slightly higher for non-SSOQ than for SSOQ farmers. The SSOQ farmers, had to make full harvest of their stocks at certain maturity of the crop to make the pond empty for next stocking. Although the non-SSOQ farmers used to make more number of stocking, they did not have to make the pond empty and generally used to harvest only the bigger size shrimps and leave the smaller ones for harvest at a later stage of more grown-up size. Therefore, the non-SSOQ farmers used to get relatively higher price for their shrimp.

Table 4.5: Costs and returns per hectare of shrimp culture by farmer category (2004)

Items	SSOQ:CST	SSOQ:MTT	Non-SSOQ
A. Fixed cost (Tk)	37746.45	22063.93	21969.06
B. Variable cost (Tk)	270889.21	52594.81	52215.11
C. Gross cost (A+B) (Tk)	308635.66	74658.74	74184.17
D. Shrimp yield (kg)	1140.10	338.12	209.45
E. Shrimp price (Tk/kg)	355.87	347.35	361.04
F. Gross return (DxE) (Tk)	405724.77	117446.87	75618.21
G. Gross margin (F-B) (Tk)	134835.56	64852.06	23403.10
H. Net return (F-C) (Tk)	97089.11	42788.13	1434.04
I. Benefit-cost ratio (BCR) (F/C)	1.31	1.57	1.02
J. Break-even yield (C/E) (kg)	867.27	214.94	205.47
K. No. of farms obtaining negative net return	6	6	14

Source: Field Survey 2005

Table 4.5 shows that net return per hectare for CST, MTT and non-SS0Q farms were Tk. 97,089, Tk. 42,788 and Tk. 1,434 respectively. Benefit-cost ratio (BCR), measured as the ratio of gross return to gross cost, were 1.31, 1.57 and 1.02 for the CST, MTT and non-SSOQ farms respectively. The lower average net return of only Tk. 1,434 for the non-SSOQ farms may be attributed to the fact that some farms in this group incurred heavy loss, and 50% of the farms earned negative net returns.

Thus in absolute term, CST farms generated per hectare gross revenue about 5 times higher than that of the non-SSOQ farms. Gross revenue of the MTT farms was about 50% higher than that of the non-SSOQ farms. Net returns per hectare of the CST and MTT farms were respectively about 68 times and 30 times higher than those of the non-SSOQ farms. Thus both gross and net returns per hectare of the CST and MTT farms were overwhelmingly higher than those of the non-SSOQ farms. The higher yield, gross and net returns of the CST and MTT farms would definitely contribute to higher income earning from both individual and national point of view, and Table 4.5 shows that net return per hectare of the CST farms was more than double the net return of the MTT farms. However, the picture can be looked at from a different point of view. Table 4.5 also shows that benefit-cost

ratios of the CST and MTT farms were 1.31 and 1.57 respectively, implying that return per Taka invested was substantially higher for MTT than for CST farms. Thus from investment point of view, the MTT farms were more profitable than the CST farms.

Production under Closed System Technology required huge amount of money and therefore resource-poor farmers would be unable to adopt the technology. As can be seen from Table 4.5, the break-even yields for CST, MTT and non-SSOQ farms were 867 kg, 215 kg and 205 kg respectively, implying that the minimum yield required to avoid loss was several times higher for the CST farms than that for the MTT and non-SSOQ farms. To depict the overall picture, while non-SSOQ farms were marginally profitable, MTT farms were more profitable than both non-SSOQ and CST farms. It should also be mentioned here that 14 out of 28 non-SSOQ farms, 6 out of 16 MTT farms and also 6 out of 21 CST farms earned negative returns from their investment. Obviously, the proportion of farms earning negative net return was higher for non-SSOQ than for SSOQ farms. Disease was the main cause of crop failure and hence lower returns for the non-SSOQ farmers. Field visits and focus group discussion revealed that for SSOQ farmers, crop failures were due to a combination of factors such as improper site selection for pond, poor management and incidence of disease.

4.5 Adoption of SSOQ Technology

Adoption of a technology can be viewed from different dimensions. One is the acceptance and use of the technology by number or proportion of persons in a reference population in a geographical area. The other dimension is the change in the number of persons adopting the technology over time. Another dimension is the extent of adoption or use of the essential components of the technology. Sustainability of the adopted technology can be viewed as another dimension because a technology once adopted and soon abandoned can not represent adoption in true sense of the term.

The SSOQ technologies are being popularized in three major shrimp producing districts namely Khulna, Satkhira and Bagerhat. Records obtained from the District Fisheries Office of these districts showed that there were 44,141 brackish water shrimp farms in these areas. Records obtained from the SSOQ office showed that there were only 274 farmers who adopted SSOQ technologies over a three years period of demonstration in the areas. Thus in percentage term this was quite a negligible (less than 1 per cent) figure and could not be termed as a substantial rate of adoption.

As regards change in the number of persons adopting the technology over time, records available from the SSOQ office showed that the total number of farms adopting the technology increased from 3 in 2003 to 36 in 2004 and 274 in 2005. The additional number of farms adopting the technologies were 33 in 2004 and 238 in 2005. This would be regarded as a high rate of change in adoption.

The Evaluation Team observed through field visits that most of the farmers adopting the technologies, particularly the CST adopters, were quite seriously practicing the technologies in terms of adherence to the recommended practices pertaining to the component elements of the technologies. Cross-checking with a number of critical variables such as stocking density, feeding, fertilizing and other management practices revealed that most of the adopters were practicing the technologies in accordance with the guidelines provided by the extension personnel. One unique feature observed was maintenance of written records of all the management practices and financial transactions by the farmers. The farmers were able to provide all the required information in absolute or parameterized form from the written records. They reported that they were taught these record keeping practices by the project personnel. This was a remarkable contribution of the project initiative.

There was a question item in the interview schedule, asking farmers as to whether they would continue practicing the technologies in the future. One hundred percent adopters reported that they would continue with the technology because they got stimulated by the increased survival rates of the fries/shrimps, high yield and

hence good financial returns. There were, however, a few instances of crop failure and farmers, with assistance from the technical experts of the project, identified that in most cases the failures were due to some lapses in the pond management practices. In one instance, for example, a farmer got frustrated and decided to discontinue with the technology. But having observed success of the neighboring adopters in the next crop, he revised his opinion and resumed practicing the technology. These are some of the positive indicators of adoption of the SSOQ technology.

4.6 Spillover Effect of Technology Adoption

An important indicator of success of a technology is its replication in the self-propelling manner. An attempt was made in this exercise to assess the spillover effect of the SSOQ technologies in terms of adoption of the technologies by the non-intervention farmers. The survey schedule administered in the field contained some questions for the respondents as to how many neighboring farmers had adopted or shown interest in the adoption of the technologies. Responses obtained from 21 CST farmers revealed that 75 neighboring farmers actually adopted the technology and another 810 showed interest in the adoption of the technology. As for the MTT, responses obtained from 16 adopter farmers revealed that 24 neighboring farmers adopted the technology and another 259 showed interest in the adoption of the technology. It may be mentioned that MTT was introduced only from early 2005 and just one crop was harvested by mid July 2005. Thus the impact of the technology was yet to be amply manifested in the area.

Attempt was also made to get the opinion of the non-adopter farmers about adoption of the SSOQ technology. Of the 28 non-adopters, all reported to have heard about the technology and 22 of them (78 per cent) were willing to adopt the technology. Thus the results obtained from the opinion survey suggest that there was a reasonably high degree of spillover effect of the SSOQ technology in the shrimp belt areas of Bangladesh.

Sustainability Issues

Having provided the above evidence, some comments on the sustainability of adoption of the technology seem to be in order:

The mechanism of supervision and monitoring at the stage of technology trial and demonstration provides some implications for future needs of supervision when the project activities will not be there. SSOQ has put vigorous efforts in monitoring and supervision of the demonstration and extension. The program has 28 extension personnel based at its Khulna site. Of the 28 personnel, 9 are Extension Officers and 19 are Pond Technicians. The pond technicians work under the supervision of the Extension Officers at the field level. By the year 2005, the program has been extended to 274 farmers covering a total pond area of 923 ha. These information indicate that the technologies are highly supervision-intensive. One may therefore wonder as to what would be the level of performance of the technologies after withdrawal of the supervision.

The SSOQ did not have a strong built-in formal training program for the farmers or for the extension agents. The interview with the farmers during field survey revealed that on an average, the CST and MTT farmers received formal training for 2 and 7 days respectively. For sustainability of the technology, there should be provision of training for building knowledge base among the greater mass of farmers and the extension personnel. However, the intensive hands-on training being offered to the farmers in the field are expected to make a significant impact on sustainability of the technology. The critical issue would be to organize the trained farmers into viable groups, so that they would be interacting among themselves in matters of trouble shooting and sustainable management of the technologies. The research and extension support from public, private and NGO sectors would be highly warranted in this regard.

There are different categories of farmers with respect to knowledge, resource base and enthusiasm about shrimp culture. The CST is a capital intensive technology and is expected to be adopted by relatively richer farmers. However, the MTT has been tailored to make suitable for adoption by the large majority of small and

marginal groups with financial constraints. Availability of credit at lower interest rate is an important determinant of adoption of technology in a sustainable manner. During field visits the farmers complained that while the processing firms were getting loan at only 5% interest, often with additional subsidy in shipment, they had to borrow money at 8% interest rate. There should be provision of credit to the small and marginal farmers at concessional rate of interest.

4.7 Impact of SSOQ Technology on Export Earning

Data available from the Export Promotion Bureau (EPB) suggest that although shrimp export exhibited steady increase, value of export fluctuated over the past years, mainly because of price changes. However, both volume and value of shrimp export substantially increased over the past two years. In 2003-04, Bangladesh exported 43 thousand tons of frozen shrimp, valued at US$ 352 million (Taka 21527 million). Increased production of shrimp definitely contributes to increased exports, but all incremental gain in production do not necessarily go to the export channel.

There has been an attempt through the SSOQ initiative to estimate the project's impact on shrimp export on the basis of virus free larvae released through the PCR laboratory of Cox's Bazar station. For example, in 2004 a total of 540 million virus free larvae were released through the PCR laboratory. Of these, only about 1 million PLs were stocked in the demonstration ponds. Assuming that the remaining PLs were stocked in the non-SSOQ ponds, and assuming a survival rate of 33 percent, it was estimated that a total of 172 million shrimps were produced and exported, valued at US$ 26 million.

The estimate is based on a number of assumptions, some of which might appear to be quite fragile. In the first place, certain specified quantity of PL would have to be tested through the PCR lab owned by the project. Second, the survival rate has been assumed to be 33 percent. Results obtained from the survey revealed that survival rate of commonly available fry in the ordinary pond was only about 12 percent. A particular survival rate of the disease free PL (question remaining as to how long the PLs remain disease free under ordinary management) in the ordinary

pond has not yet been established. Also, it has been assumed that all the shrimp produced would find their way in the export market. The plausibility of all these assumptions may be questionable. Thus, derivation of the export earning figure does not appear to stand on a solid ground. A great deal of caution would therefore have to be maintained in attributing a specified export earning to the project initiative. However, since the project is significantly contributing to productivity of shrimp, its potential impact on export need not be undermined and potentially, the project can make even bigger contribution to export in the near future.

4.8 Financial Sustainability Plan of SSOQ

The SSOQ initiative has recently done an exercise on "hypothetical revenue generation", based on the assumption of testing a specified number of larvae, 360 crores and 720 crores respectively in 2005 and 2006. Assuming a 'surcharge' for SSOQ at the rate of Tk. 50 per 1000 PL, the exercise suggests a revenue generation of Tk. 1.80 crores and 3.60 crores for the years 2005 and 2006 respectively. Assuming that the cost of nationwide SSOQ set up would be around Tk. 1.30 crores, the exercise derives revenue surplus of Tk. 0.50 crores and Tk. 2.30 crores for years 2005 and 2006 respectively. The implication drawn from the exercise is that "SSOQ can sustain on its own if left to operate independently as a Private Limited Company for profit or a Private Company under the Societies Act".

There is nothing wrong in doing a financial sustainability plan based on a set of assumptions. The critical issue will be execution of the plan in terms of number of PLs being tested per time period and collection of charge at a market determined rate. It should be mentioned that the PCR lab owned by the SSOQ is not likely to be the only lab in the area. One hatchery (Niribili) has already a PCR testing lab and other labs may be established in the area. Thus SSOQ would be expected to run the PCR lab on a commercial basis in a future market scenario. The plan will therefore need to stand the test of time and circumstances obtaining round the shrimp industry in Bangladesh.

5.0 Conclusions and Recommendations

5.1 Conclusions

The Shrimp Seal of Quality Initiative seems to have been making substantial positive impact on pond based shrimp culture in the south western coastal region of Bangladesh. Provision of disease free post larvae and innovative pond management practices have contributed to substantial yield increase. Results from farm survey have shown that farms adopting SSOQ technology obtained much higher yield than those not adopting the technology. For the adopter farms, yield after adoption was much higher than that before adoption.

Financial benefits were also much higher for the adopter farms compared to the non-adopter farms. For the adopter farms, while gross return for the CST farms was several times higher than that for the MTT farms, net return for the former group was about twice the net return for the latter group of farms. However, the benefit-cost ratio, which represents return per Taka of investment, was substantially higher (1.57) for the MTT than for the CST farms (1.31). Thus from investment point of view, MTT farms were earning more return from their investment than the CST farms. The Closed System technology was highly capital intensive and as such most of the small and marginal farmers would not be able to afford the technology without adequate credit support.

The SSOQ technology seems to be rapidly expanding in the shrimp belt areas of Bangladesh. Although the number of adopters as percent of total shrimp farms are not yet high, the project activities have created a lot of enthusiasm among the local farmers and quite a large number of farmers are expected to adopt the technologies in the coming days. Field visits revealed that quite a good number of neighboring farmers already adopted the technologies by following the management practices being pursued by the SSOQ adopter farmers.

The proposition of the project's making any significant contribution to export earning seems to be premature, the prospect of making such contribution in the near future seems to be quite high, though. The proposition of financial

sustainability of SSOQ as a Private Limited Company has to stand the test of time and circumstances obtaining round the shrimp industry in Bangladesh.

The most weak dimension of SSOQ operation is its lack of understanding and cooperation/collaboration with some vital public and private sector bodies such as the DOF, BFRI and BFFEA. The DOF is the most important public sector body responsible for dissemination of fishery and aquaculture technologies in the country. The organization has the built-in infrastructure for promoting fish culture technologies in the far flung areas of the country. These facilities need to be utilized for ensuring cost-effective means of dissemination of technologies. Besides, many of the research issues in respect of refinement of technologies can be resolved through effective collaboration with the Saline Water Station of the BFRI, located at Paikgacha, Khulna. For increasing export, useful collaboration with BFFEA will have to be ensured Effective collaboration with the related institutions and organizations are not only important during project implementation, but also for sustainable utilization of the technologies and other positive impacts that the project leaves behind. It has been evident through study of relevant documents that some desperate attempts to seek collaboration from the relevant stakeholder bodies miserably failed. This need not be used as a pretext for not seeking fresh cooperation/collaboration with these bodies, particularly with changes (if any) of the personality factors (which often matter much) associated with the stakeholder organizations and SSOQ itself.

5.2 Recommendations

It has been evident through the Evaluation that a lot of positive impacts have been generated in the shrimp production sector through the SSOQ efforts. Since the project has performed only for less than three years, it is suggested that the efforts be continued for a few more years (3-5 years) so that the positive impacts can be further propagated and the results can be consolidated. However, a number of issues need to be addressed for obtaining sustainable outcomes from the project initiatives. These are outlined below.

- There should be separate technology for catching brood shrimp from the sea for ensuring sustainable harvest of brood shrimp. Program for domestication of broods can also be taken up as a long term gesture, especially in view of seasonality and uncertainty of brood availability in the off seasons.
- Screening of PL is only one aspect of the use of disease free larvae. Hatchery health, hygiene and sanitation should be maintained at the highest level to avoid contamination of the PL.
- Many hatcheries maintain foreign technicians who generally show reluctance to train local technicians in the technical aspects of hatchery operation. This acts as a hindrance to building up of trained manpower in the hatchery technology. Measures should taken to train and utilize local technicians for sustainable utilization of hatchery technology.
- Synchronization of requirement of virus free seed in the field and production or supply of seed through PCR testing is a critical determinant of efficient utilization of the PCR tested seed. Measures should be taken to match the demand/requirement with production/supply through careful planning and prior scheduling of breeding/spawning and stocking.
- Mortality rate of the PL should be further minimized. Nursery management system should be improved at different stages such as at the hatchery, at the farm and if necessary, at the major seed distribution points.
- Inter agency collaboration should be improved for deriving better outcomes from the technology generation and dissemination efforts. The SSOQ authority should take fresh initiative to secure collaboration with DoF, BFRI and BFFEA for obtaining sustainable improvement in production, processing and export of good quality shrimp from Bangladesh.

- The project should leave behind a set of well trained farmers and extension agents for widespread dissemination of the technologies in the self propelling manner. The critical issue would be to organize the trained farmers into viable groups, so that they would be interacting among themselves in matters of trouble shooting and sustainable management of the technologies. The research and extension support from public, private and NGO sectors would be highly desirable and effective in accomplishing the desired outcomes.